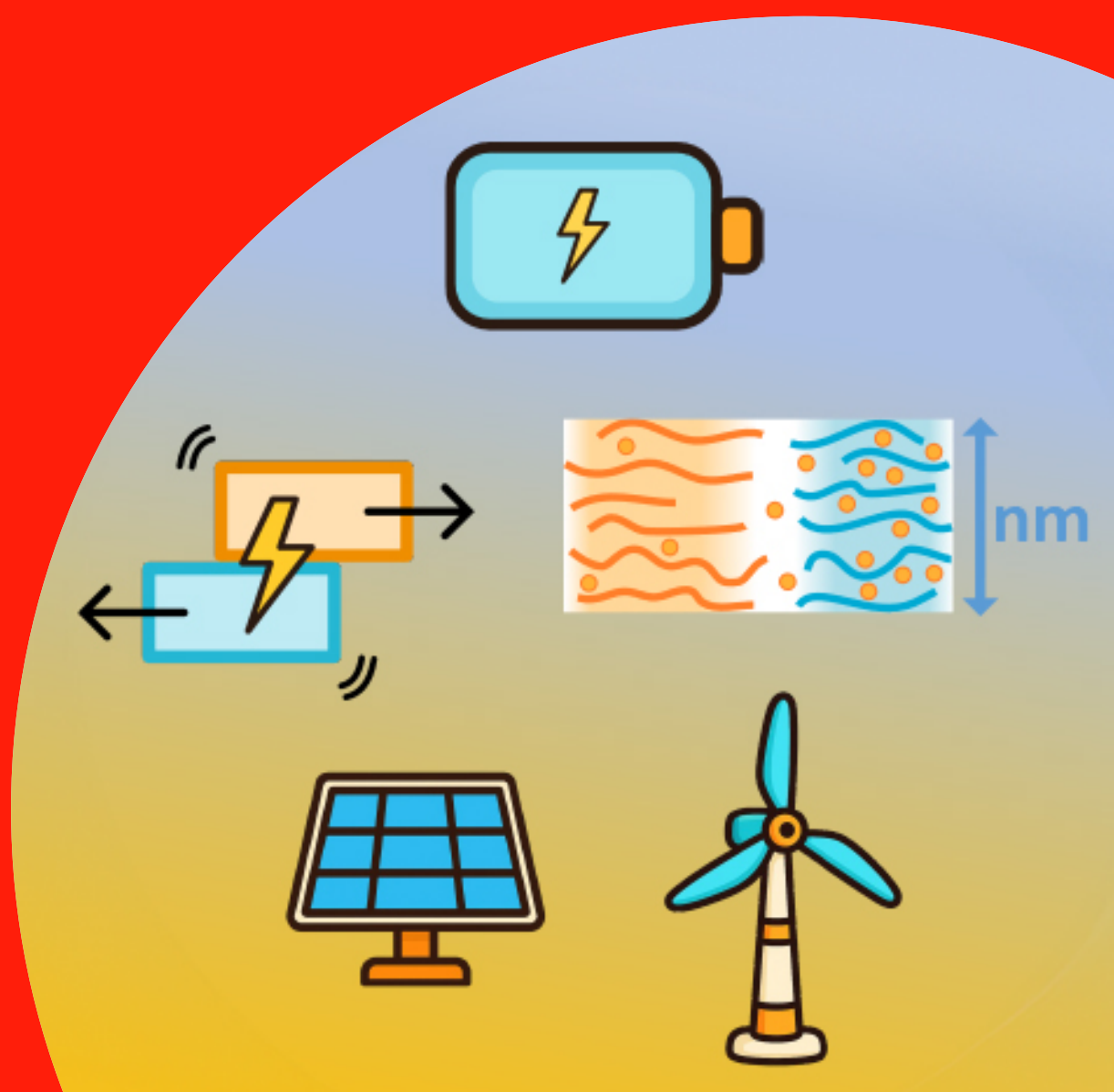


Energy-meets-Nano Workshop 2026

19 October 2026

Institute of Physics, London, UK



Programme

Time	Programme
10:00 – 10:30	Registration and Refreshments
10:30 – 10:40	Welcome & Opening remarks (Martin Munz)
	Session I (Session Chairs: David Lidzey, Ibon Santiago)
10:40 – 11:15	Invited talk 1: Prof. S. Ravi P. Silva, University of Surrey From Nanoscience to Net Zero: Carbon Nanotechnology for Smart, Flexible and Scalable Renewable Energy Systems
11:15 – 11:50	Invited talk 2: Prof. Sonya Calnan, Loughborough University A synopsis of nanomaterials uses and challenges thereof, in enhancing the efficiency of energy related processes
11:50 – 12:25	Invited talk 3: Prof. Markys Cain, Electrosiences Ltd Characterisation of macro-to-nanoscale energy harvesting devices
12:25 – 13:25	Lunch
	Session II (Session Chairs: S. Ravi P. Silva, Richard G. Forbes)
13:25 – 14:00	Invited talk 4: Prof. Lidija Siller, Newcastle University Nickel nanoparticles and aerogels for carbon capture and energy storage
14:00 – 14:15	Student talk 1: Elizabeth Colbert, Lancaster University The Making of an Apparatus for Measuring Conductance through Molecular Layers using a Syringe-Based EGaIn Junction
14:15 – 14:30	Student talk 2: James Neil, University of Surrey Organic-Inorganic Nanostructured Thermoelectric Devices: A Framework for High Power Factor and Controllable Semiconductor Typing
14:30 – 15:05	Invited talk 5: Prof. David Lidzey, University of Sheffield Microgroove perovskite solar cell modules fabricated via roll-to-roll slot die coating
15:05 – 16:05	Afternoon Break and Poster session

	Session III (Session Chairs: Lidija Siller, Yitao Wang)
16:05 – 16:40	Invited talk 6: Dr. Galo Paez Fajardo, University of Warwick How sub-nanoscale orbital and electron interactions dictate redox in battery materials
16:40 – 17:15	Invited talk 7: Prof. Shelly Conroy, Imperial College London TBC
17:15 – 17:50	Panel discussion (Moderation by Dean Kos)
17:50 – 18:00	Poster Prize Ceremony and Closing remarks

Speakers are listed in programme order

Session 1

From Nanoscience to Net Zero: Carbon Nanotechnology for Smart, Flexible and Scalable Renewable Energy Systems

Prof. S. Ravi P. Silva¹

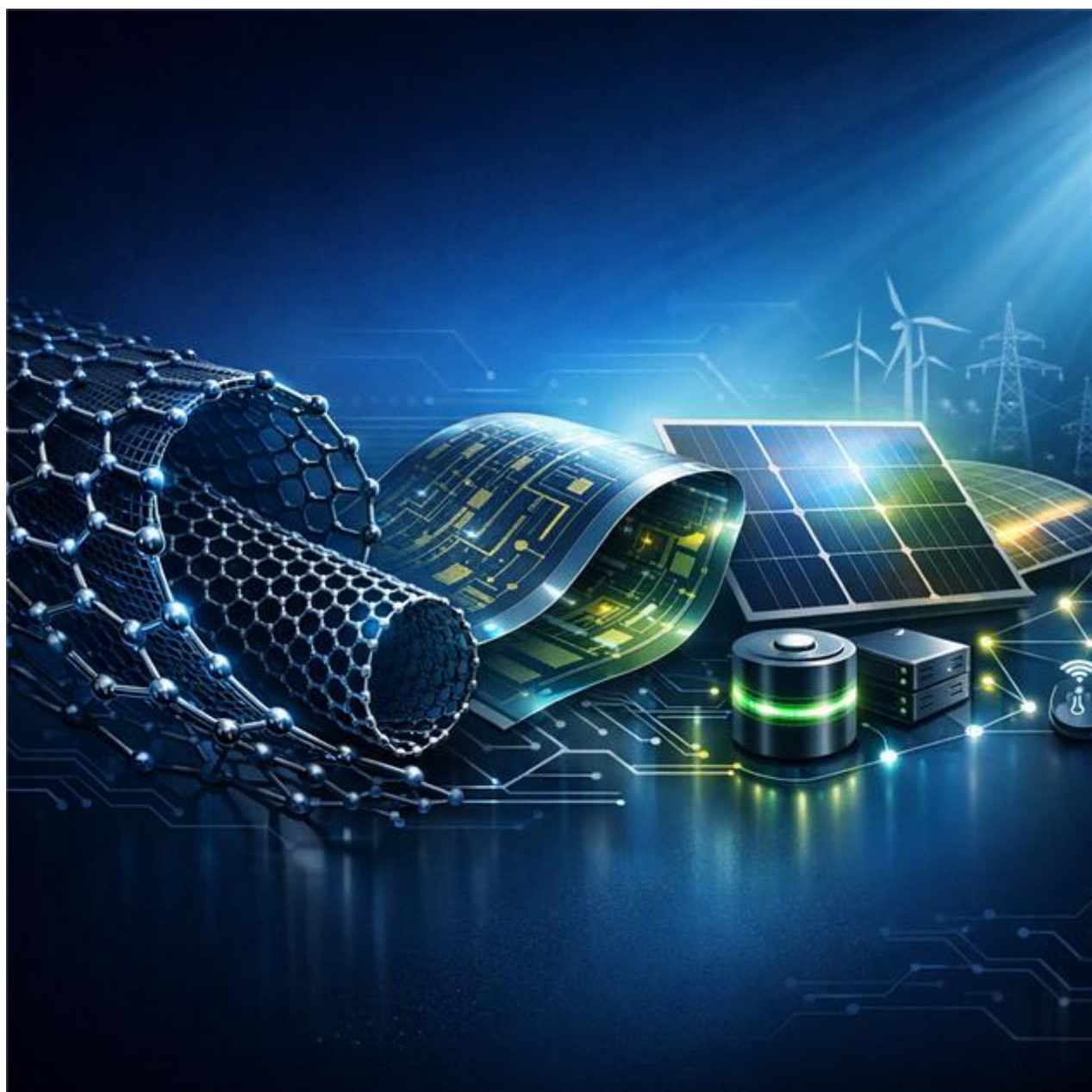
¹University of Surrey, United Kingdom

Session 1, October 19, 2026, 10:40 - 12:25

Achieving carbon net zero requires more than incremental improvements in renewable energy; it demands materials and device platforms that are efficient, scalable, flexible and embedded within future energy systems. Carbon, with its exceptional ability to hybridise into diverse nanoscale forms, offers a powerful route from nanoscience to nanotechnology, enabling material properties to be engineered for energy generation, storage, harvesting and sensing.

In this keynote I will explore how nanoscale design of carbon-based and hybrid organic-inorganic materials is shaping next-generation renewable technologies and smart large-area electronics. Examples will include fourth-generation solar cells, where carbon nanotubes, organic photovoltaics and perovskites are integrated to enhance light absorption, charge transport and mechanical resilience; printed and flexible electronics that can support distributed generation, smart grids and digital-twin-enabled energy management; and nanostructured interfaces for supercapacitors, batteries and self-powered sensors. I will also discuss ultra-black and bioinspired carbon surfaces, including graphene and diamondlike-carbon architectures, where control of morphology and optical response creates new opportunities in light management, aerospace, wearable technologies and high-sensitivity detection.

A central theme is translation: laboratory advances must be compatible with low-temperature processing, large-area manufacture and roll-to-roll production if they are to impact society at scale. By linking fundamental nanoscale physics to manufacturability, sustainability, durability and systems integration, nano-engineered carbon and hybrid materials can help power billions of future connected devices while supporting cleaner energy infrastructure. The talk will highlight how nanoscience can provide the materials toolbox for a modern, flexible and sustainable standard of living for generations to come across society worldwide equitably.



A synopsis of nanomaterials uses and challenges thereof, in enhancing the efficiency of energy related processes

Prof. Sonya Calnan¹

¹Loughborough University, United Kingdom

Session 1, October 19, 2026, 10:40 - 12:25

The complete transition away from fossil fuels for global energy needs, demands alternative energy conversion processes that combine high efficiency and low costs. Nano materials (<100 nm) by virtue of their high surface to volume ratio, have been crucial in the development of a variety of chemical reactions necessary for energy harvesting, conversion and storage processes. By tuning composition, shape and size of the nano materials, relevant properties like catalytically active surface area, work function, electrical conductivity, extinction coefficient, refractive index, mechanical properties, among others, can be tuned over a wide range. However, nanomaterials tend to gradually lose the desired nanostructure and thus functionality during application which has implications for their commercial deployment.

This talk will cover both conventional and novel cases where low imensional nano materials have been used to enhance specific phenomena to increase the efficiency of energy related technologies. Also, efforts to mitigate this challenge of loss of nanostructure related functionalities during application will be discussed. These insights will provide a strong rationale for continued research in nanomaterials for energy in the future.

Characterisation of macro-to-nanoscale energy harvesting devices

Prof. Markys Cain¹

¹Electrosiences Ltd, United Kingdom

Session 1, October 19, 2026, 10:40 - 12:25

In the development of measurement methods to probe macro-scale down to nanoscale energy related phenomena, Electrosiences have designed, developed and commercialised a new instrument that can accurately characterise piezoelectric materials. The piezoelectric coefficient is one that quantifies the degree to which a piezo material can develop electrical charge when subjected to an applied mechanical stress, or conversely, the strain that evolves as an external electrical field is applied across the same material. In this short talk, we discuss this measurement method, highlighting some results taken from the characterisation of nanoscale energy harvesting materials/structures. We also attempt to examine how we got there: from outline ideas to prototyping, manufacturability and sustainability challenges to a full working commercial instrument. There are many skills and resources needed to take an idea to commercial success and some of those might surprise many.

Session 2

Nickel nanoparticles and aerogels for carbon capture and energy storage

Prof. Lidija Šiller¹

¹Newcastle University, United Kingdom

Session 2, October 19, 2026, 13:25 - 15:05

We present recent results on the application of nickel nanoparticles and aerogels to technologies relevant to global warming mitigation:

- nickel nanoparticles as heterogeneous catalysts in carbon capture and mineralization – from fundamentals to scale up [1],
- an economical method for synthesis of aerogel nanoporous materials for use in super insulation and as carriers of nanodiamonds [2],
- modified graphene aerogels as charge storage devices [3].

[1] Šiller L and Bhaduri GA, Carbon Capture, PCT/GB2013/051243 (WO 2013171480 A2, WO2013171480 A3, US20150151248 A1, EP2849871 A2, CN104428051 A); Orendi HW, Joby K, Šiller L. Atmosphere 2024, 15(12), 1479.

[2] Šiller L and Han X, Aerogel synthesis, UK Patent, P221149GB/DW; Marof K, Šiller L. Construction and Building Materials 2025, 467, 140320.

[3] Xiong F, Wang J, Dickman N, Liu Y, Hunt MRC, Šiller L. Vacuum 2025, 232, 113846.

The Making of an Apparatus for Measuring Conductance through Molecular Layers using a Syringe-Based EGaIn Junction

Elizabeth Colbert¹, Sam Harley¹, Benjamin Robinson¹

¹School of Physics & Astronomy, Lancaster University, United Kingdom

Session 2, October 19, 2026, 13:25 - 15:05

With the uptake in AI use increasing global energy consumption, it seems only logical to look at making more energy-efficient computing architectures. One such approach involves building devices from the bottom up, such as the creation of molecular memristors - a form of non-volatile data storage[1]. A key feature of these devices is a pinched hysteresis in their IV curve. When looking for this hysteresis in molecular layers a stable electrical contact is needed, something that can be achieved with an EGaIn liquid metal junction. This measurement setup can be formed by contacting the top of a molecular layer with a conical EGaIn tip from a syringe[2]. A custom-made apparatus has been implemented to take electrical measurements using an EGaIn junction with emphasis on precise control of location, force and contact area of the EGaIn electrode on the molecular layer using an XYZ stage. The contact area is estimated using optical microscopy. This setup will be used to search for memristive switching in molecules.

References:

[1] Mario Lanza et al. The growing memristor industry. *Nature*, 640(8059):613–622, April 2025.

[2] Ryan C. Chiechi et al. Eutectic Gallium–Indium (EGaIn): A Moldable Liquid Metal for Electrical Characterization of Self-Assembled Monolayers. *Angewandte Chemie International Edition*, 47(1):142–144, 2008.

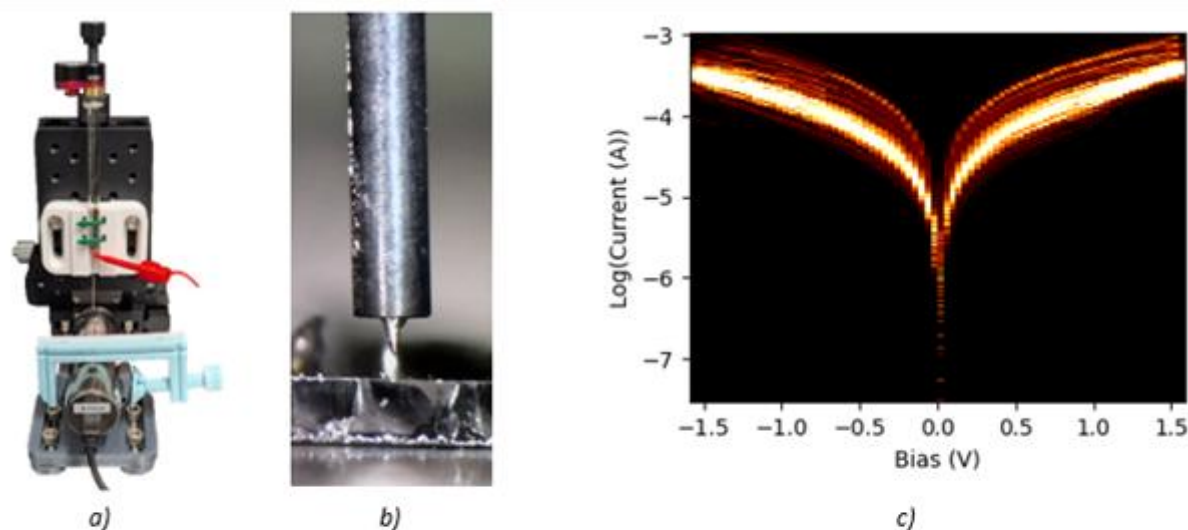


Figure 1 : a) Shows part of the EGaIn measurement apparatus, with the syringe held to the XYZ stage and the micoroscope clamped down. b) Shows an EGaIn conical tip prepared for electrical measurements. c) Shows a representative measurement taken using the apparatus.

Organic-Inorganic Nanostructured Thermoelectric Devices: A Framework for High Power Factor and Controllable Semiconductor Typing.

Mr James Neil¹, José V. Anguita^{1,2}, Adna Smajlovic³, Hidetsugu Shiozawa³, Joy Mitra⁴, Soumyadip Hazra⁴, S Ravi P. Silva^{1,2}

¹University of Surrey, Advanced Technology Institute (ATI), United Kingdom, ²University of Surrey, Institute of Sustainability, United Kingdom, ³Faculty of Physics, University of Vienna, Austria, ⁴School of Physics, CAMRIE ISSER TVM, India

Session 2, October 19, 2026, 13:25 - 15:05

Achieving UN SDG Goal 7.3, which aims to double global energy efficiency, requires the development of energy scavenging technologies to reclaim wasted energy and support next-generation energy systems. A study of global energy use reports that 61% of energy losses occur as heat, presenting a significant opportunity for recovery via implementation of thermoelectric generators (TEGs). However, widespread adoption is limited by significant material challenges. Current state-of-the-art chalcogenide-based devices are expensive, made from scarce materials, and raise toxicity concerns, limiting viability. Organic polymers, by contrast, have been investigated as a potential replacement, offering low material costs, solution processability and flexible TEG device architectures.

Herein, we present a route to develop the thermoelectric performance of organic semiconductor PEDOT:PSS via incorporation of ultrathin metal layers into PEDOT:PSS thin films. This technique was found to result in synergistic enhancement of the Seebeck coefficient and electrical conductivity, properties that typically exhibit an inverse relationship, thereby overcoming a key challenge in thermoelectric optimisation. Optical and temperature-dependent characterisation supported by density functional theory simulations indicate that these improvements arise from metal-dependent polymer morphology modifications and de-doping, via metal-semiconductor interfacial charge transfer, alongside reconfiguration of the band structure.

Utilising this approach, we demonstrate a sevenfold enhancement to the power factor relative to pristine PEDOT:PSS, representing a significant step towards the performance of chalcogenide-based devices. Furthermore, we report that careful selection of metallic interlayers facilitates control of semiconductor typing, enabling both p- and n-type behaviour to be attained, enhancing the prospects of PEDOT:PSS-based TEG designs.

Microgroove perovskite solar cell modules fabricated via roll-to-roll slot die coating

Prof. David Lidzey¹

¹University of Sheffield, United Kingdom

Session 2, October 19, 2026, 13:25 - 15:05

Perovskite photovoltaics (PV) offer a promising route to low cost, low carbon solar energy, but progress toward large scale deployment is partly limited by manufacturing scalability, stability, and dependence on scarce materials. In this talk, I discuss a long-standing collaboration with the UK company Power Roll Ltd which has explored the development of so-called microgroove perovskite solar cells. These devices are very different from 'regular' planar solar cells, but are created by embossing a series of micron wide and deep grooves into a flexible plastic film. Using a directional coating technique, opposing walls of the grooves are first coated with n- or p-type extraction contacts. By then depositing a MAPbI₃ perovskite semiconductor within the grooves, a module composing of hundreds of series-connected PV devices can be realized. Such devices can be fabricated using conventional roll-to-roll deposition techniques and do not contain scarce and expensive elements such as indium and can also be shown to undergo bifacial operation.

I chart the demonstration of this technology from early, single-groove structures that had a power conversion efficiency of around 7% [1], to much larger modules comprising of 1000's of grooves having a PCE of 12.5%. A critical tool in our research is the use of nanofocus XRF and XRD performed at the Diamond Light Source [2]. This synchrotron-based technique allows the composition of a material to be quantitatively mapped with a maximum spatial resolution of 50 nm, permitting us to characterize the distribution of the perovskite and the contact materials within each groove. I highlight the use this technique to explore the structure of groove devices using a tomographic imaging technique and demonstrate that it can reveal hidden voids and defects within the perovskite [3]. I also show that it is also able to chart the degradation of the perovskite under accelerated aging conditions, with the breakup of perovskite grains and changes in lead to iodine ratio evidenced.

[1] A flexible back-contact perovskite solar micro-module, Wong-Stringer et al, Energy Environ. Sci. (2019) 12, 1928

[2] Back-Contact Perovskite Solar Cell Modules Fabricated via Roll-to- Roll Slot-Die Coating: Scale-Up toward Manufacturing, Blackburn et al, ACS Appl. Energy Mater. (2025) 8, 2219–2228

[3] Fully Roll-to-Roll Coated Large-Area Perovskite Solar Modules on Indium-Free Microgroove Substrates, Hill et al, Submitted for publication (2026)

Session 3

How sub-nanoscale orbital and electron interactions dictate redox in battery materials

Dr. Galo Paez Fajardo¹

¹University of Warwick, United Kingdom

Session 3, October 19, 2026, 16:05 - 17:15

As battery technologies evolve towards smaller particles and increasing utilisation of active materials, understanding the reactions that occur within battery electrodes becomes increasingly important. But what determines which atoms actually accommodate charge during these reactions? At the atomic scale, energy storage in Li-ion batteries is commonly understood through changes in the oxidation state of transition metals, corresponding, in the classical redox picture, to changes in the occupancy of their 3d orbitals, i.e., 3d-electron counting. This framework underpins how we understand and select materials for battery applications, implicitly assuming that 3d-electron counting provides a consistent description across the transition-metal series. Here, we show that this assumption does not hold universally: the nature of redox depends critically on the nature and strength of electronic interactions at the sub-nanoscale, including bond disproportionation, intersite charge fluctuations and strong metal–ligand hybridization. Using two canonical battery materials, $\text{LiMn}_0.6\text{Fe}_{0.4}\text{PO}_4$ (LMFP64) and LiNiO_2 (LNO), we demonstrate how these interactions give rise to fundamentally different mechanisms of charge compensation. LMFP64 follows the classical transition-metal redox picture, whereas in LNO, strong Ni–O interactions lead to a ligand-hole-driven redox mechanism in which a simple transition-metal electron-counting description breaks down. More broadly, our results contribute to understanding the role of oxygen in Ni-rich redox, an open question in the development of cathode materials for high-energy-density applications, while highlighting the need for battery-material design rules that account not only for elemental composition, but also for the sub-nanoscale interactions that determine their electronic structure and redox behaviour.

Poster Presentations

Nanostructured optical superabsorbers for energy generation and heat management in space

Dr. Jose Anguita¹, Ravi Silva¹

¹Advanced Technology Institute, University of Surrey, United Kingdom

Afternoon Break and Poster Session, October 19, 2026, 15:05 - 16:05

Optical superabsorbers are capable of achieving near-unity absorption across broad spectral ranges, offering significant opportunities for sustainable energy harvesting from the environment and thermal management in space. One class of materials exhibiting such remarkable optical properties is vertically aligned multiwalled carbon nanotubes (VA-MWCNTs). Their optical superabsorption properties have been known for several decades [1]. However, to date, there is no universally accepted mechanism that fully explains the origins of this remarkable optical behaviour. Several mechanisms have been proposed, including optical transitions associated with van Hove singularities, optical scattering, absorption by amorphous phases, and refractive-index matching. However, none of these explains the continuous and broadband absorption observed.

Here, forests of VA-MWCNTs are grown on sapphire substrates to measure their optical properties from the ultraviolet to the infrared. Electromagnetic wave propagation modelling reveals the absorption is strongly governed by the in-plane electrical conductivity of the graphitic nanotube walls, whereas variations in through-plane conductivity have little influence. An equivalent inductive-capacitive-resistive model further suggests that optical energy is dissipated through resistive damping within the concentric graphitic shells of the multiwalled nanotubes.

We further couple this material to a thermoelectric device to demonstrate its potential for harvesting environmental radiative heat as well as cooling. Simulations show these could enable radiative heating and cooling without the need for forced-air circulation, highlighting potential for energy-efficient thermal-management technologies [2].

[1] Pulickel, M. Ajayan et al., Nano Lett. 13 February 2008; 8 (2): 446–451.

[2] Anguita, J.V., Yang, K., Silva, S.R.P. et al., Energy Environ. Mater. e70396. <https://doi.org/10.1002/eem2.70396> (2026).

Plasma-Activated Textile Electrodes with Borophene Nanosheets for High-Performance Flexible Supercapacitors

Nitesh Choudhary, Sajib Roy, S. Ravi P. Silva, Pradip K. Maji

Afternoon Break and Poster Session, October 19, 2026, 15:05 - 16:05

The rapid advancement of smart power technologies requires flexible, lightweight, and high-performance energy storage systems. In this work, borophene-modified silver cloth electrodes are developed as a promising platform for flexible supercapacitor applications. Borophene, an emerging two-dimensional boron-based material, possesses high electrical conductivity, a large accessible surface area, and favourable surface chemistry, making it attractive for rapid charge storage and efficient ion/electron transport.

Pristine Ag cloth was selected as a flexible and conductive current collector. Before active material deposition, the Ag cloth was activated using oxygen plasma treatment to enhance surface wettability, generate active surface sites, and improve adhesion between the textile substrate and borophene nanosheets. Borophene was subsequently synthesized, dispersed, and deposited onto the plasma-treated Ag cloth through a coating process. Different borophene weight percentages were investigated to optimise active material loading, electrode uniformity, ion diffusion pathways, and electrical conductivity.

The fabricated electrodes were characterized using FTIR, XRD, RAMAN, SEM, and TEM to examine functional groups, crystallinity, structural features, and nanosheet morphology. Electrochemical performance was evaluated using Gamry workstation CV, GCD, and EIS to analyse good capacitive behaviour, resistance, charge–discharge response and cycling retention for the flexible supercapacitor device.

A highly accurate formula for electrostatic field enhancement by a lightning-rod shape

Prof. Thiago Albuquerque De Assis¹, Fernando Fuzinatto Dall'Agnol², Richard Gordon Forbes³

¹Physics Institute, Universidade Federal Fluminense, Brazil, ²Department of Exact Sciences and Education, Universidade Federal de Santa Catarina, Brazil, ³Quantum Sciences Group, School of Mathematics and Physics, University of Surrey, United Kingdom

Afternoon Break and Poster Session, October 19, 2026, 15:05 - 16:05

Electrostatic (ES) field enhancement at sharp conducting structures is important in several technological application areas, including the theory of electron-emission sources and theories of electrical breakdown in accelerators and electron microscopes. Thus, ES field enhancement forms part of the theory of some of the "machines of nanotechnology" used for examining or modifying nanomaterials, in "energy" and other contexts. A canonical geometry for studying this effect is the hemisphere-on-cylindrical-post (HCP) model, in the regime where the structure stands on a planar conductor of large lateral extent, with a large gap between the structure and counter-electrode. A significant parameter is the apex field enhancement factor γ_a [$\equiv$ "apex ES field"/"background ES field"]. For this structure, γ_a can be written $\gamma_a = c_a(\sigma_a) \times \sigma_a$, where the apex sharpness ratio σ_a is given by the ratio ("post-height"/"apex-radius-of-curvature"), and the apex sharpness coefficient $c_a(\sigma_a)$ depends on the post shape. For the HCP model, no exact analytical formulas for $c_a(\sigma_a)$ or γ_a are currently known. (Quite possibly, none exist.) This work develops a compact analytical approximation for $c_a(\sigma_a)$ and hence for γ_a , for the HCP model. This formula has a "logarithmic-style" structure, rather than the "power-style" structure used in previous approximations. When compared with precise finite-element analyses of the HCP model, over the computationally accessible range $1 \leq \sigma_a \leq 1000$, this "logarithmic-style" formula has a maximum error-magnitude of 0.15%, which is significantly better than older approximations. Details of our methodology of derivation, and some consequences of the resulting formula, are discussed.

On the need to define a fuller set of atomic-level constants, symbols, units and abbreviations

Dr Richard Forbes

¹School of Maths and Physics, University of Surrey, United Kingdom

Afternoon Break and Poster Session, October 19, 2026, 15:05 - 16:05

In the International System of Quantities (ISQ), which involves a set of equations that form the basis for SI units, there are three "extensive" quantities, namely "mass", "(electric) charge" and "amount-of substance". Following the 2019 modifications to the ISQ, the quantity "amount of substance" can logically be treated as a formalisation of the process of counting (though not everyone would currently agree to do this). At the macroscopic level, each of these extensive quantities has a named unit and a recognised abbreviation for this unit (e.g., for charge we have "Coulomb" and "C"). At the "nanoscale" or "atomic-scale" level, two of the quantities have defined atomic-level constants: namely mass has the "unified atomic-level constant" μ , and electric charge has the "elementary charge" e . Only one of the quantities has a defined atomic-level unit and an abbreviation for it: namely mass has the unit the "Dalton" (abbreviation: Da) [or, alternatively, the "unified atomic mass unit" (abbreviation" u)]. It will be argued in this Poster that, in various "nanoscale" or "atomic-scale" contexts, it would be advantageous for the International Standards Organization to introduce a complete set of atomic-scale entities (name and symbol for atomic-level constant, and name and abbreviation for corresponding atomic-level unit) for all three of the extensive ISQ quantities. Some merits of doing this will be discussed, and some specific suggestions for nomenclature will be made.

Improving the Precision of Thermoelectric Atomic Force Microscopy Measurements

Dr Sam Harley¹, Benjamin Robinson¹

¹Lancaster University, United Kingdom

Afternoon Break and Poster Session, October 19, 2026, 15:05 - 16:05

Technologies which utilise the thermoelectric effect for energy conversion offer a potential solution for the scalable harvesting of 'low grade' waste heat. However, existing thermoelectric materials provide low efficiency and power output, and are often toxic, scarce, or harmful to the environment; a new generation of nanostructured organic materials could leverage mesoscopic quantum transport effects to deliver enhanced performance.

Thermoelectric atomic force microscopy (ThAFM) enables direct nanoscale characterisation of the thermopower of such materials. Unfortunately, the precision and reproducibility of ThAFM measurements is often limited by instrumentation difficulties in measuring the thermovoltage induced at the tip-sample junction. In this work, key sources of error in ThAFM were identified and used to establish design criteria for a high-precision thermovoltage amplifier module. The resulting device offers performance surpassing other ThAFM implementations reported to date.

Two-dimensional materials for sustainable energy storage and conversion

M.M. Faisal¹, Rhys Williams¹, Sivakkumaran Sukumaran¹, Qaisar Abbas¹, Oliver Rigby², Stephen Campbell², Lidija Šiller³, **Dr Michael Hunt**¹

¹Department Of Physics, Durham University, United Kingdom, ²Department of Mathematics, Physics and Electrical Engineering, Northumbria University, United Kingdom, ³School of Engineering, Newcastle University, United Kingdom

Afternoon Break and Poster Session, October 19, 2026, 15:05 - 16:05

The drive toward net-zero emissions creates a pressing need for environmentally sustainable energy storage and conversion. While electrochemical technologies are promising, they face challenges that nanostructured two-dimensional (2D) materials can address. Here, we present recent advances utilizing 2D materials to enhance supercapacitor performance and develop non-noble metal electrocatalysts for green hydrogen evolution:

- (1) Few-layer graphene (FLG) platelets produced by exfoliation into surfactant-stabilized suspensions act as highly effective conductive additives in flexible activated carbon-based electric double-layer capacitors if introduced via a novel vacuum infiltration technique [1]. Optimizing FLG size and loading yields significantly higher specific energy density than carbon black additives.
- (2) We demonstrate an asymmetric aqueous supercapacitor using pseudocapacitive MoS₂ and MnO₂ on carbon cloth (CC) [2]. Optimizing the electrolyte achieves a ~2.0 V potential window, extended cycle life and performance metrics comparable with, or superior to, similar devices reported elsewhere.
- (3) Binder-free CC-supported MoS₂ electrocatalysts were optimized for green hydrogen production in alkaline media [3]. Tuning hydrothermal synthesis temperatures controls phase composition, morphology, stoichiometry and crystallinity. A 230 °C synthesis yields optimal composition, providing enhanced HER activity with an overpotential of 98 ± 3 mV (at 10 mA cm⁻²) and a 108 ± 5 mV dec⁻¹ Tafel slope.

[1] Williams, R. E., Sukumaran, S., Abbas, Q., & Hunt, M. R. C. Carbon, 218 (2024) 118744

[2] Faisal, M. M., Rigby, O. M., Campbell, S., & Hunt, M. R. C. Electrochimica Acta, 532 (2025). 146294.

[3] Faisal, M. M., Šiller, L., & Hunt, M. R. C. Electrochimica Acta, 538 (2025) 146809.

The EPIC Model: A Proposed Framework for Inclusive Nanoscience Education Through Triboelectric Energy Harvesting

Mr Oluwasefunmi Igbekele Oluyede¹

¹Ten Plus One Ltd , United Kingdom

Afternoon Break and Poster Session, October 19, 2026, 15:05 - 16:05

The presentation introduces the EPIC Model (Equitable Physics through Inquiry and Community Engagement), a framework emerging from classroom practice in multicultural settings to make nanoscience more meaningful and accessible. The model integrates four dimensions— Equity, Pedagogy, Inquiry, and Community— within a structured cycle of planning, delivery, assessment and reflection.

The framework is illustrated by a proposed classroom activity using low-cost triboelectric nanogenerators (TENGs), which convert mechanical motion into electrical energy through contact electrification and electrostatic induction. Using accessible materials such as plastic film, adhesive tape and aluminium foil, learners can investigate charge transfer, surface properties, energy conversion and sustainable energy access without requiring expensive laboratory equipment.

The Inquiry dimension supports student-led investigation and scientific reasoning. The Community dimension connects the activity to local energy challenges and invites learners to consider who benefits from, and who may be excluded by, emerging technologies. Equity positions students' cultural identities, experiences and community knowledge as assets, while Pedagogy provides scaffolding and multiple ways to participate and demonstrate understanding.

The EPIC Model therefore offers a practical, scalable approach for connecting nanoscale physics with inclusive, socially responsive education, currently being refined for future postgraduate research. The presenting author is willing to give an oral presentation if a contributed-talk opportunity is available.

Battery-Free Sensing with 2D Nanomaterial-Engineered Triboelectric Nanofibres for Wearable Systems

Sajib Roy¹, S. Ravi P. Silva¹

¹University of Surrey, United Kingdom

Afternoon Break and Poster Session, October 19, 2026, 15:05 - 16:05

Triboelectric nanogenerators (TENGs) offer a promising nanotechnology platform for converting low-frequency mechanical motion into electrical energy and sensing signals. Their performance, however, is often limited by insufficient charge generation, rapid charge dissipation, and weak response to gentle or intermittent excitation. Here, we develop a composite nanofibre TENG by integrating 2D borophene nanosheets into electrospun PVDF-HFP and pairing it with nylon 66.

Borophene serves as more than a conductive nanofiller. During electrospinning, the 2D nanosheets alter the electrical behaviour of the polymer jet, producing finer and more uniform fibres with a larger active surface area. Borophene-polymer interfaces also create interfacial polarisation, nanoscale charge-storage regions and electron-trapping sites. These coupled effects enhance dielectric behaviour, surface charge density and mechanical-to-electrical energy conversion.

A textile-integrated sensor array translates these material advances into biomechanical energy harvesting and self-powered sleep monitoring. The system detects body position and subtle movement under low-pressure contact. At the optimum borophene concentration, the device delivers a 13-fold increase in power density compared with pristine PVDF-HFP nanofibres. It also achieves a pressure sensitivity of $53.8 \pm 1.2 \text{ V kPa}^{-1}$ and remains stable during repeated cycling. Higher borophene loading causes nanosheet aggregation, creates leakage pathways and reduces charge retention. This work establishes nanoscale interface engineering as a transferable strategy for linking nanomaterial dispersion, dielectric behaviour and charge transport with energy conversion and self-powered wearable sensing.

Lab-Tools NMR Cryoporometry (NMRC) to measure porosity for carbon sequestration

Dr. Beau Webber¹

¹Lab-tools Ltd. (nano-science), United Kingdom, ²Engineering, Mathematics and Physics, University of Kent (LASE)., United Kingdom

Afternoon Break and Poster Session, October 19, 2026, 15:05 - 16:05

We study of the nano-scale properties of liquids in pores and at interfaces, primarily using NMR.

We use thermodynamic techniques, in particular NMR Cryoporometry, to measure pore-size distributions, surface areas and pore volumes

Thermodynamic pore-sizing methods are based on the Gibbs Equations :

Constant Temperature variant : the Kelvin Equation - hence gas adsorption pore-sizes.

Constant Pressure variant : the Gibbs-Thomson Equation - NMR Cryoporometry pore-size distributions : Measurement range sub-1nm to over 1µm - Nondestructive.

Gibbs–Thomson equation for the melting point depression, T_m , for a small isolated spherical crystal, of diameter x , in its own liquid, may be expressed as [2] :

$$\Delta T_m = T_m^{\infty} - T_m(x) = \frac{4\sigma_{sl}T_m^{\infty}}{x\Delta H_f\rho_s}$$

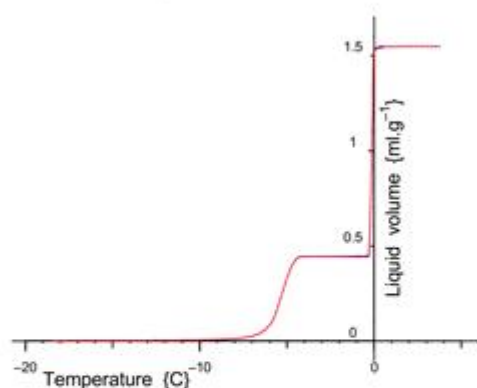
It is important to note that k_{GT} includes a term dependent on pore geometry, as does the Kelvin equation. k_d is the geometry term, and is equal to four for a spherical liquid-crystalline interface (conventionally assumed for cylindrical pores). T_m is the bulk melting point and the other terms are thermodynamic and density terms [2].

Using this technique, we have made recent measurements on 10 samples of North Sea sandstone porous rock, from the British Geological Society, to measure pore-volume and pore size distributions.

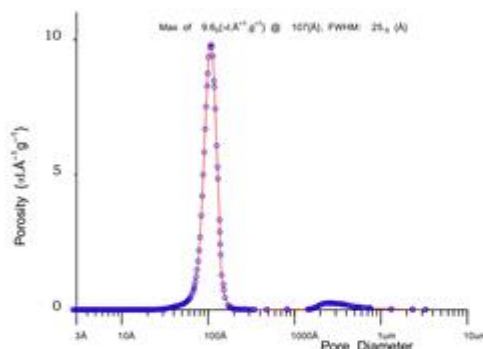
We have also measured the quantity and viscosity of the as-recovered liquids in these porous rocks.

Based upon samples supplied by the British Geological Survey © UKRI

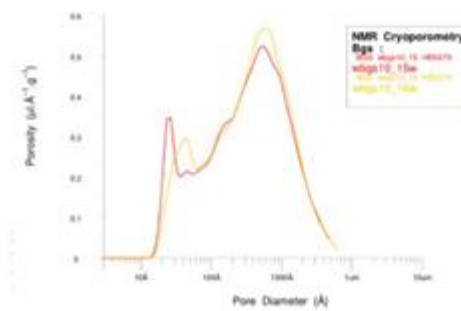
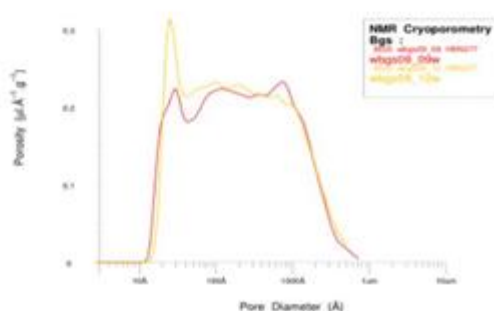
Melting Curve : Merck 100A Sol-Gel



NMRC pore size distribution: Merck 100A Sol-Gel



Melting curve for a liquid in the pores transformed to a porosity distribution using Gibbs-Thomson Eqn.



Pore Size Distributions for BGS Sandstone samples 9, 10, measured using NMR Cryoporometry.

References

1. *Characterisation of Porous Solids by NMR*. J.H. Strange, M.Rahman and E.G. Smith, Physical Review Letters, 71, No. 21,p3589-3591, 1993
2. *Nuclear Magnetic Resonance Cryoporometry* J. Mitchell, J. Beau W. Webber and J.H. Strange. Physics Reports, 461, 1-36, 2008. DOI: 10.1016/j.physrep.2008.02.001
3. *An evaluation of NMR Cryoporometry, Density Measurement and Neutron Scattering methods of pore characterisation*. J.B.W. Webber, J.H. Strange and J.C. Dore. Mag. Res. Imag., 19, 3-4, 395-399, 2001.
4. *Studies of nano-structured liquids in confined geometry and at surfaces*. J. Beau W. Webber. Progress in NMR Spectroscopy, 56, 1, 78-93, 2010. DOI: 10.1016/j.pnmrs.2009.09.001
5. *An NMR study of porous rock and biochar containing organic material*. J. Beau W. Webber, Patrick Corbett, Kirk T. Semple, Uchenna Ogbonnaya, Wayne S. Teel, Carrie A. Masiello, Quentin J. Fisher, John J Valenza II, Yi-Qiao Song, QinHong Hu. Proceedings of the 11th International Bologna Conference on Magnetic Resonance in Porous Media (MRPM11), University of Surrey, 2012. Microporous and Mesoporous Materials, 178, 94-98, 2013. DOI: 10.1016/j.micromeso.2013.04.004
6. *Pushing the Limits of NMR Cryoporometry in Polymers from Nanometer to Micron*. J.B.W. Webber, A Welle, V Livadaris, A Andreev – 2020 <https://chemrxiv.org/doi/pdf/10.26434/chemrxiv.13247291.v1>.

Energy-meets-Nano Workshop 2026
19 October 2026
Institute of Physics, London, UK